DESCRIPTION

HERMETIC COMPRESSOR

TECHNICAL FIELD

The present invention relates to a hermetic compressor used in a refrigerator with freezer, etc.

BACKGROUND ART

As a conventional hermetic compressor, for example, Japanese Patent Unexamined Publication No. 2002-195160 discloses a compressor equipped with a discharge valve system, which reduces noise during operation and improves energy efficiency by reducing loss at the time of opening and closing of a discharge reed.

Hereinafter, a conventional hermetic compressor is described with reference to drawings.

Fig. 7 and Fig. 8 are a sectional view and a plan view showing a conventional hermetic compressor, respectively. Fig. 9 and Fig. 10 are a side-sectional view and an exploded view showing a discharge valve system of a conventional hermetic compressor, respectively.

In Figs. 7 to 10, hermetic container 1 includes discharge tube 2 and suction tube 3 connected to a cooling system (not shown). Furthermore, hermetic container 1 stores oil 4 in its bottom portion, accommodates motor element 7 composed of stator 5 and rotor 6 and compressor element 8 driven by motor element 7. The inside of hermetic container 1 is filled with refrigerant 9.

Next, a main configuration of compressor element 8 is described.

Cylinder 10 includes substantially cylindrical compressing chamber 11

and bearing 12. Valve plate 13 has discharge valve system 14 at the outer side of cylinder 10 so as to close compressing chamber 11. Head 15 covers valve plate 13. Suction muffler 16 is opened in hermetic container 1 at one end and communicates to compressing chamber 11 at another end. Crank shaft 17 has main shaft 18 and eccentric shaft 19, which is supported by bearing 12 of the cylinder and to which rotor 6 is press-fitted and fixed. Piston 20 is inserted into compressing chamber 11 in a way in which it can slidably reciprocate and connected to eccentric shaft 19 via connecting rod 21.

Next, discharge valve system 14 provided on compressor element 8 is described referring to Fig. 9.

Valve plate 13 has concave portion 22 at the outer side of cylinder 10. Concave portion 22 is provided with discharge hole 23 communicating to cylinder 10 and valve seat 24 formed so as to surround discharge hole 23. Valve plate 13 is provided with pedestal 25 formed on substantially the same plane as valve seat 24. Discharge reed 26, spring reed 27 and stopper 28 are fixed to pedestal 25 by rivet 29 in this order.

Discharge reed 26 is formed of a tongue-shaped plate spring material. Discharge reed 26 includes discharge reed holding portion 30 fixed to pedestal 25 and opening/closing portion 31 for opening and closing valve seat 24.

Spring reed 27 is formed of a tongue-shaped plate spring material. Spring reed 27 includes spring reed holding portion 32 fixed to pedestal 25 and movable portion 33, and has bending portion 34 in the vicinity of the root of opening/closing portion 31 of discharge reed 26.

Stopper 28 includes stopper holding portion 35 fixed to pedestal 25 and regulation portion 36 for regulating the movement of discharge reed 26. Regulation portion 36 of stopper 28 is formed substantially parallel in a cross sectional view to a plane including valve seat 24 and pedestal 25.

Movable portion 33 of spring reed 27 is adjusted by adjusting a bending angle of bending portion 34 so as to have predetermined space between movable portion 33 and opening/closing portion 31 of discharge reed 26 and between movable portion 33 and regulation portion 36 of stopper 28.

Hereinafter, an operation of the above-configured hermetic compressor is described.

When electricity is supplied to motor element 7, rotor 6 is rotated and crank shaft 17 is driven to rotate. At this time, an eccentric rotation movement of eccentric shaft 19 is transmitted to piston 20 via connecting rod 21, and thereby piston 20 reciprocates in compressing chamber 11.

Following the reciprocating movement of piston 20, refrigerant 9 in hermetic container 1 is sucked from suction muffler 16 into compressing chamber 11 and at the same time, low pressure refrigerant 9 flows into hermetic container 1 from a cooling system (not shown) though suction tube 3. Refrigerant 9 sucked into compressing chamber 11 is compressed and then discharged into head 15 by way of discharge valve system 14 of valve plate 13. Furthermore, high pressure gas discharged into head 15 is discharged from discharge tube 2 into a cooling system (not shown).

However, there is a problem in a conventional hermetic compressor that refrigerating capacity and efficiency vary easily.

SUMMARY OF THE INVENTION

The present invention relates to a hermetic compressor having a cylinder provided with a discharge valve system. The discharge valve system includes a discharge reed having an opening/closing portion and a discharge reed holding portion; a spring reed having a movable portion and a spring reed holding portion; and a stopper having a regulation portion and stopper holding

portion. The discharge reed, the spring reed and the stopper are fixed to a pedestal of a valve plate in this order. In a spring reed bending portion provided in the movable portion, the movable portion is bent toward the direction of a valve seat. The tip portion of the movable portion is brought into contact with a plate contact portion. Space is provided between the movable portion of the spring reed and the opening/closing portion of the discharge reed, so that the both portions are not brought into close contact with each other with oil, thus preventing the delay in closing of the discharge reed. Furthermore, since the distance of the space is stabilized in a state in which the tip portion is brought into contact with the plate contact portion, an effect of stabilizing the spring property of the discharge valve system is obtained.

The hermetic compressor of the present invention can prevent the discharge reed and the spring reed from being brought into close contact with each other and stabilize the spring property of the discharge valve system. Therefore, the present invention can provide a stable hermetic compressor with high energy efficiency.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a sectional view showing a hermetic compressor in accordance with an exemplary embodiment of the present invention.

Fig. 2 is a plan view showing a hermetic compressor in accordance with an exemplary embodiment of the present invention.

Fig. 3 is a side sectional view showing a discharge valve system when it is closed in accordance with an exemplary embodiment of the present invention.

Fig. 4 is an exploded view showing a discharge valve system in accordance with an exemplary embodiment of the present invention.

Fig. 5 is a side sectional view showing a discharge valve system when it

is opened in accordance with an exemplary embodiment of the present invention.

Fig. 6 is a graph showing a spring property of a discharge valve system in accordance with an exemplary embodiment of the present invention.

Fig. 7 is a sectional view showing a conventional hermetic compressor.

Fig. 8 is a plan view showing a conventional hermetic compressor.

Fig. 9 is a side sectional view showing a discharge valve system of a conventional hermetic compressor.

Fig. 10 is an exploded view showing a discharge valve system of a conventional hermetic compressor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present inventors have found that in a conventional hermetic compressor, right after the hermetic compressor starts to be operated, a phenomenon sometimes occurs, in which a lower refrigerating capacity as compared with a usual refrigerating capacity is maintained for a relatively long time. The present inventors have succeeded in elucidating the mechanism of discharge reed 26 and spring reed 27 by analyzing the behaviors thereof. Therefore, firstly, the mechanism is described with reference to Figs. 7 to 10. In Fig. 9, the direction in which the discharge reed is closed is represented by "In" direction to cylinder 10 and the direction in which the discharge reed is opened is represented by "Out" direction to cylinder 10.

At the starting time of the hermetic compressor when this low refrigerating capacity phenomenon easily occur, oil 4 together with refrigerant 9 returns from a refrigerating cycle (not shown). Then, since oil 4 together with refrigerant 9 is compressed and discharged, much oil 4 intervenes between discharge reed 26 and spring reed 27.

Furthermore, in general, when a hermetic compressor starts to be operated, a suction pressure is high, refrigerant 9 with a relatively high density is compressed and discharged until the pressure in hermetic container 1 is reduced, and large load is applied to opening/closing portion 31 of discharge reed 26. On the other hand, since the displacement of opening/closing portion 31 of discharge reed 26 is regulated by regulation portion 36 of stopper 28, opening/closing portion 31 of discharge reed 26 is strongly pressed by high density refrigerant 9 toward movable portion 33 of spring reed 27 that is disposed between opening/closing portion 31 of discharge reed 26 and regulation portion 36 of stopper 28.

Since large pressing load is applied as mentioned above, opening/closing portion 31 of discharge reed 26 and movable portion 33 of spring reed 27 are brought into close contact with each other by oil 4. That is to say, discharge reed 26 and spring reed 27 are integrated with each other and carry out an opening/closing operation as if one thick sheet of discharge reed carries out the opening/closing operation.

Herein, movable portion 33 of spring reed 27 is bent toward the opening direction ("Out" direction) of discharge reed 26 at bending portion 34. As a result, the spring force of spring reed 27 acts in the opening direction ("Out" direction) opposite to closing direction ("In" direction) in which discharge reed 26 is closed, so that discharge reed 26 is pulled toward the opening direction ("Out" direction) and thus timing of closing is delayed.

As a result, when piston 20 shifts to the suction stroke in compressing chamber 11 after the upper dead center, the opening time of discharge reed 26 is longer. During the time, inside compressing chamber 11, high pressure refrigerant flows backward and substantial displacement volume of the piston is decreased. Consequently, a low refrigerating capacity phenomenon occurs.

During the occurrence of this low refrigerating capacity phenomenon, the efficiency of a hermetic compressor is bad. Consequently, power consumption is increased and at the same time, cooling of refrigerating equipment on which this hermetic compressor is mounted is decelerated.

Furthermore, since the space between movable portion 33 of spring reed 27 and opening/closing portion 31 of discharge reed 26 is adjusted by adjusting a bending angle of bending portion 34 of spring reed 27, the space between movable portion 33 of spring reed 27 and opening/closing portion 31 of discharge reed 26 varies easily. When discharge reed 26 is opened, the displacement varies easily until discharge reed 26 is brought into contact with spring reed 27. That is to say, an inflection point, in which the spring force of discharge reed 26 shifts to the synthetic spring force of discharge reed 26 and spring reed 27, varies, thus causing variation in the spring property.

Therefore, it is thought that the opening amount and closing timing of discharge reed 26 easily vary, and as a result, refrigerating capacity and efficiency may vary.

The present invention has been made based on the elucidation of the mechanism of the above-mentioned low refrigerating capacity phenomenon, and the present invention provides a stable hermetic compressor in which delay in closing of a discharge reed hardly occurs and energy efficiency is high.

The hermetic compressor of the present invention includes a valve plate having a discharge valve system at the outer side of a cylinder. The discharge valve system includes a discharge hole formed in the valve plate; a valve seat provided around the discharge hole on the outer side of the valve plate; a pedestal formed in substantially the same height as that of the valve seat on the outer side of the valve plate; a plate contact portion formed on the valve plate at a position that is higher than the valve seat on the outer side of the

valve plate; a discharge reed made of a plate spring material having the opening/closing portion covering the discharge hole in a way of capable of opening and closing thereof; a spring reed made of a plate spring material provided at the outer side of the discharge reed; and a stopper provided at the outer side of the spring reed. The spring reed has a spring reed bending portion and a tip portion in the movable portion. In the spring reed bending portion, the spring reed is bent toward the direction of the valve seat and the tip portion thereof is brought into contact with the plate contact portion.

Even when oil intervenes between the discharge reed and the spring reed and excessive load is applied to the discharge reed at the starting time, etc., since space is formed with respect to the discharge reed in the position corresponding to the discharge reed opening/closing portion, close contact due to the intervening oil can be prevented. Furthermore, since the distance of the space is stabilized in a state which is brought into contact with the plate contact portion, the spring property of the discharge valve system can be stabilized. Thus, a stable hermetic compressor with high energy efficiency can be provided.

Hereinafter, an exemplary embodiment of the present invention is described with reference to drawings.

(EXEMPLARY EMBODIMENT)

Fig. 1 and Fig. 2 are a sectional view and a plan view showing a hermetic compressor in accordance with an exemplary embodiment of the present invention, respectively. Fig. 3 is a side sectional view showing a discharge valve system when it is closed in accordance with the exemplary embodiment of the present invention; Fig. 4 is an exploded view showing the discharge valve system; Fig. 5 is a side sectional view showing the discharge valve system when it is opened; and Fig. 6 is a graph showing a spring property of the discharge valve system. In Figs. 1 and 2, the direction in which the

discharge reed is closed is represented by "In" direction to the cylinder and the direction in which the discharge reed is opened is represented by "Out" direction to the cylinder.

In Figs. 1 to 6, hermetic container 101 includes discharge tube 102 and suction tube 103 connected to a cooling system (not shown) and stores oil 104 in its bottom portion. Furthermore, hermetic container 101 accommodates motor element 107 composed of stator 105 and rotor 106 and compressor element 108 driven by motor element 107. The inside of hermetic container 101 is filled with refrigerant 109. It is preferable that refrigerant 109 to be used is refrigerant that measures with environmental problem of recent years and is other than specified chlorofluorocarbons. For example, R134a, natural refrigerant R600a, and the like, are preferable as refrigerant 109.

Next, a main configuration of compressor element 108 is described.

Cylinder 110 includes substantially cylindrical compressing chamber 111 and bearing 112. Valve plate 113 has discharge valve system 114 on the outer side of cylinder 110 (side of "Out") so as to close compressing chamber 111. Head 115 covers valve plate 113. Suction muffler 116 is opened in hermetic container 101 at one end and communicates to compressing chamber 111 at another end. Crank shaft 117 has main shaft 118 and eccentric shaft 119, which is supported by bearing 112 of cylinder 110 and press-fitted and fixed into stator 105. Piston 120 is inserted into compressing chamber 111 in a way in which it can slidably reciprocate and connected to eccentric shaft 119 via connecting rod 121.

Next, discharge valve system 114 provided on compressor element 108 is described referring to Fig. 3.

Valve plate 113 has recess 122 at the outer side of cylinder 110 (side of "Out"). Recess 122 is provided with discharge hole 123 penetrating through

valve plate 113 and communicating to cylinder 110, and with valve seat 124 surrounding discharge hole 123. Valve plate 113 is further provided with pedestal 125 formed on the side of "Out" in substantially the same plane as valve seat 124, and with plate contact portion 126. Plate contact portion 126 is formed substantially parallel to a plane including valve seat 124 and pedestal 125 in the cross sectional view.

Discharge reed 127, spring reed 128 and stopper 129 are fixed to pedestal 125 by rivet 130 in this order. Discharge reed (as a first plate spring) 127 is formed of a tongue-shaped plate spring material and includes discharge reed holding portion 131 fixed to pedestal 125 and opening/closing portion 132 for opening and closing the valve seat 124.

Spring reed (as a second plate spring) 128 is formed of a tongue-shaped plate spring material and includes spring reed holding portion 133 fixed to pedestal 125 and movable portion 134. Movable portion 134 is bent toward the direction of valve seat 124 ("In" direction) at spring reed bending portion 135 provided in movable portion 134. Tip portion 136 is brought into contact with plate contact portion 126 of the valve plate.

Stopper 129 includes stopper holding portion 137 fixed to pedestal 125 and regulation portion 138 for regulating the movement of discharge reed 127. Regulation portion 138 of stopper 129 is formed substantially parallel to a plane including valve seat 124 and pedestal 125. That is to say, the surface of regulation portion 138 is substantially parallel to valve seat 124 and pedestal 125.

Height of plate contact portion 126 provided in valve plate 113 is set so that movable portion 134 of spring reed 128 has space between movable portion 134 and opening/closing portion 132 of discharge reed 127 and between movable portion 134 and regulation portion 138 of stopper 129 stably.

Opening/closing portion 132 of discharge reed 127 is bent toward the direction of valve seat 124 at discharge reed bending portion 139.

Between valve seat 124 and pedestal 125, a portion that is deeper than pedestal 125 is provided as clearance groove 140. Discharge reed bending portion 139 is located in a region of clearance groove 140 at the outer side of clearance groove 140. That is to say, a concave portion formed on the surface of valve plate 113 forms clearance groove 140 and the bottom surface of the concave portion is formed lower in height than valve seat 124 and pedestal 125.

Regulation portion 138 of stopper 129 is provided at the tip with stopper contact portion 141 formed of a surface that bends toward spring reed 128. Stopper contact portion 141 is formed substantially parallel to a plane including valve seat 124 and pedestal 125. That is to say, stopper contact portion 141 is substantially parallel to plate contact portion 126.

Hereinafter, an operation and effect of the above-configured hermetic compressor is described.

When electricity is supplied to motor element 107, rotor 106 is rotated and crank shaft 117 is driven to rotate. At this time, an eccentric rotation movement of eccentric shaft 119 is transmitted to piston 120 via connecting rod 121, and thereby piston 120 reciprocates in compressing chamber 111.

Following the reciprocating movement of piston 120, refrigerant 109 in hermetic container 101 is sucked from suction muffler 116 into compressing chamber 111 and at the same time, low pressure refrigerant 109 flows into hermetic container 101 from a cooling system (not shown) though suction tube 103. Refrigerant 109 sucked into compressing chamber 111 is compressed and then discharged into head 115 by way of discharge valve system 114 of valve plate 113. Furthermore, high pressure gas discharged into head 115 is discharged from discharge tube 102 into a cooling system (not shown).

Herein, at the starting time of a hermetic compressor, oil 104 together with refrigerant 109 returns from a refrigerating cycle (not shown). Then, since oil 104 together with refrigerant 109 is compressed and discharged, much oil 104 intervenes between discharge reed 127 and spring reed 128.

Furthermore, in general, when a hermetic compressor started to be operated, a suction pressure is high. Therefore, refrigerant 109 with a relatively high density is compressed and discharged until the pressure of hermetic container 1 is reduced, and large load is applied to opening/closing portion 132 of discharge reed 127.

On the other hand, since the displacement of opening/closing portion 132 of discharge reed 127 is regulated by regulation portion 138 of stopper 129, opening/closing portion 132 of discharge reed 127 is strongly pressed by high density refrigerant 109 toward movable portion 134 of spring reed 128 disposed between opening/closing portion 132 of discharge reed 127 and regulation portion 138 of stopper 129. As a result, opening/closing portion 132 of discharge reed 127 and movable portion 134 of spring reed 128 tend to be brought into close contact with each other with oil 104.

However, in the first exemplary embodiment, since spring reed bending portion 135 is formed in movable portion 134 of spring reed 128, even when spring reed 128 is pressed to the "Out" side, between opening/closing portion 132 of discharge reed 127 and movable portion 134 of spring reed 128, as shown in Fig. 5, space 142 is formed. Since space 142 exists, even if movable portion 134 of spring reed 128 and opening/closing portion 132 of discharge reed 127 are brought into close contact with each other, they can easily be peeled off from each other. That is to say, the close contact is not continued and spring reed 128 and discharge reed 127 are not operated integrally. Therefore, delay in closing can be prevented.

As a result, a low refrigerating capacity phenomenon caused by the backflow of high pressure refrigerant into compressing chamber 111 can be prevented.

When spring reed 128 is not pressed toward the "Out" side, as shown in Fig. 3, tip portion 136 of spring reed 128 is brought into contact with plate contact portion 126 provided in valve plate 113. Therefore, movable portion 134 of spring reed 128 can have space stably between movable portion 134 and opening/closing portion 132 of discharge reed 127. When discharge reed 127 opens in the "Out" direction, the displacement until it is brought into contact with spring reed 128 becomes stable. That it to say, it is possible to suppress variation in the inflection points at which the spring force of discharge reed 127 shifts to the synthetic spring force of discharge reed 127 and spring reed 128, thus stabilizing the spring property.

As a result, variation in opening amount of discharge reed 127 and closing timing is suppressed and thus the refrigerating capacity and efficiency can be stabilized.

Therefore, it is possible to provide a stable hermetic compressor having small variation and high energy efficiency.

Furthermore, since opening/closing portion 132 of discharge reed 127 is bent toward valve seat 124 at discharge reed bending portion 139, spring force for pressing to valve seat 124 is applied to opening/closing portion 132 of discharge reed 127.

Therefore, opening/closing portion 132 of discharge reed 127 can be prevented from floating from valve seat 124, and thus more excellent sealing property can be maintained. Thus, it is possible to provide a hermetic compressor with higher energy efficiency.

Furthermore, between valve seat 124 and pedestal 125, a recess portion

that is deeper than pedestal 125 is provided as clearance groove 140. Since discharge reed bending portion 139 is located corresponding to the outer side of clearance groove 140, it is possible to prevent clearance groove 140 from being pressed by pedestal 125 and spring force of spring reed 128. As a result, the force by which opening/closing portion 132 of discharge reed 127 is pressed to valve seat 124 can be obtained stably. Sealing property between opening/closing portion 132 and valve seat 124 is improved. Thus, efficiency can be further improved.

Furthermore, according to the exemplary embodiment, regulation portion 138 of stopper 129 is provided with stopper contact portion 141 bending toward spring reed 128. Therefore, even after spring reed 128 is brought into contact with stopper contact portion 141, discharge reed 127 can be further displaced. As a result, the spring property of discharge reed 127 has two inflection points as shown in Fig. 6, three stages of properties can be obtained.

In Fig. 6, first inflection point P1 corresponds to a point at which opening/closing portion 132 of reed 127 is brought into contact with movable portion 134 of spring reed 128. After first inflection point P1 and before second inflection point P2, synthetic spring force of opening/closing portion 132 of spring reed 127 and movable portion 134 of spring reed 128 can be obtained.

Second inflection point P2 corresponds to a point at which movable portion 134 of spring reed 128 is brought into contact with stopper contact portion 141 of stopper 129. After second inflection point P2, a supporting mechanism of the spring reed is changed from cantilever type to dual support type, so that the spring force is further increased.

As mentioned above, since two inflection points and three stages of properties are obtained, as the opening amount of discharge reed 127 becomes larger, the spring force works more strongly and the closing speed is increased.

Thus, even in a high circulation region in which discharge reed 127 opens largely, few delay in closing occurs. It is possible to provide a hermetic compressor with high energy efficiency.

INDUSTRIAL APPLICABILITY

As mentioned above, the present invention can provide a stable hermetic compressor having high energy efficiency in which the delay in closing of discharge reed hardly occurs even in a case where the circulation amount of refrigerant is relatively large. Therefore, the hermetic compressor in accordance with the present invention can be used for refrigerating and air-conditioning equipment using CO_2 refrigerant.